Novel Fully MRI Compatible Nonmagnetic and Dielectric Pneumatic Servo Motor for MRI Guided Surgical Robotics

Wylonis, Leo (School: Conestoga High School)

Safe and precise robot-assisted intervention using magnetic resonance imaging (MRI) guidance requires motors that are fully MRI-compatible using no metallic or magnetic materials to ensure no degradation of MR images due to the associated negative impact on signal-to-noise ratio (SNR). This research involves development of a novel fully MRI compatible turbine-based motor design, the DiSERVO motor, and a comparison of its performance and benefits vs. the leading PneuStep rotary stepper motor designed by researchers at Johns Hopkins University. A DiSERVO motor prototype was developed in CAD and constructed using primarily custom 3D printed PLA plastic parts along with some commercially available dielectric parts. The motor is designed to move at large angular rotations via air flow through a micro-tesla turbine and at small angular movements via a brake-pulse method. A pneumatic controller module was assembled for controlling the motor through plastic hose cables and plastic fiber optic cables from an MRI safe distance of five meters. Tests were conducted to measure torque, speed, accuracy and angular resolution of movement and compare to the PneuStep motor. Testing results revealed that the DiSERVO motor achieves up to 67% faster speeds and improved torque at the same operating pressures and hose lengths as compared to the PneuStep motor. The DiSERVO motor has an angular resolution over 7 times higher than the PneuStep motor with a lower maximum angular error. The DiSERVO motor is a promising potential alternative to the PneuStep design for MRI guided surgical robotic applications.

Awards Won:
Fourth Award of $500
King Abdulaziz &amp
his Companions Foundation for Giftedness and Creativity: On-line Mawhiba Universal Enrichment Program
King Abdulaziz &amp
his Companions Foundation for Giftedness and Creativity: Award of $500
Association for the Advancement of Artificial Intelligence: Second Award of $1,000